



Dryden Flight Research Center
Edwards, California 93523-0273

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DRYDEN CENTERWIDE PROCEDURE

CODE SH

LABORATORY SAFETY

Electronically Approved by:
Associate Director

Approved by:
Acting Director, Safety and Mission Assurance

Approved by:
Chief, Safety, Health, and Environmental Office

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1.0 INTRODUCTION

1.1 Purpose

This Dryden Centerwide Procedure (DCP-S-029) establishes basic safety procedures and guidance for chemical laboratories at DFRC.

1.2 Applicability

DCP-S-029 applies to government and non-government personnel at DFRC and at DFRC controlled off-site locations. Applications may include chemistry, material science, or biological research conducted in fixed, mobile, or airborne laboratories.

1.3 Scope

DCP-S-029 establishes procedures and guidelines, delegates authorities, and assigns responsibility for control of chemicals used in laboratory settings. Laboratory workplaces covered by this DCP are those where chemicals are used in a non-routine, non-production manner by persons with adequate training and knowledge to accomplish the process safely.

1.4 Policy

Exposure to chemicals will be kept As Low As Reasonably Achievable (ALARA) while giving consideration to programmatic requirements but in no case will exposure exceed either OSHA Permissible Exposure Limits (PELs) or American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs[®]).

2.0 DEFINITIONS

2.1 Action Level: The level of concentration of an airborne substance calculated on an 8 hr. time weighted average and which initiate certain activities such as monitoring or medical surveillance.

2.2 Acute Toxicity - The toxic effect of a substance that has a rapid onset, sharp or severe effects, and pronounced symptoms but is not chronic.

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- 2.3 Chemical Hygiene Plan - A written plan developed and implemented by the employer that establishes the procedures, equipment, personal protective equipment, and work practices to protect employees from health hazards caused by chemicals used in laboratory settings. The plan must meet the requirements of 29 CFR 1910.1450 guidelines.
- 2.4 Chronic Toxicity - Harmful health effects that develop over time and last for a long time. Effects may have a delayed onset.
- 2.5 Designated Area - An area which may be used to work with “select carcinogens,” reproductive toxins, or substances which have a high degree of acute toxicity. An area may be the entire laboratory, a specific area of a laboratory, or a device such as a fume hood.
- 2.6 Designated Carcinogen - A carcinogen that meets the criteria for OSHA “select carcinogen” or falls into Category 1 or 2 of the ACGIH’s list of carcinogens.
- 2.7 Flammable Chemical - An aerosol, gas, liquid, or solid chemical that meets the OSHA definition of flammable.
- 2.8 Hazardous Chemical - A chemical for which there is statistically significant evidence, based on at least one study conducted in accordance with established scientific principles, that acute or chronic health effects may occur if employees are exposed.
- 2.9 Health Hazard - Includes chemicals that are carcinogens, toxic or highly toxic, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic systems, or agents that damage the lungs, skin, eyes or mucous membranes.
- 2.10 Laboratory - A facility where the “laboratory scale use of hazardous chemicals” occurs, or a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.
- 2.11 Laboratory Scale - Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. Workplaces which produce commercial quantities of materials are excluded.

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- 2.12 Particularly Hazardous Substances - Select carcinogens, reproductive toxins, compounds with a high degree of acute toxicity and highly flammable or explosive substances. Chemicals and substances that require special handling.
- 2.13 Protective Laboratory Practices and Equipment - Laboratory procedures, practices, and equipment accepted by laboratory health and safety professionals as effective, or those that the employer can show to be effective in minimizing employee exposure to hazardous chemicals.
- 2.14 Regulated Area - A work area with limited access where substances are regulated by a specific OSHA standard.

For additional definitions see 29 CFR 1910.1450 (b), “definitions,” and DCP-S-038, Hazard Communications, Appendix A: DFRC Data Sheet Instruction Guide and Dictionary.

3.0 REFERENCES

3.1 Authority Documents

- 3.1.1 29 CFR 1910.1450: Occupational Exposure To Hazardous Chemicals In Laboratories. This is the primary authority document governing Chemical Laboratory functions. It supersedes, for laboratories, the requirements of OSHA health standards in 29 CFR 1910, Subpart Z except as defined in 29 CFR 1910.1450 (a) (2) (i) (ii) and (iii)
- 3.1.2 American Conference of Governmental Industrial Hygienists (ACGIH); Industrial Ventilation, Current Edition. This ACGIH guideline is accepted by NASA as an authority document for ventilation requirements for chemical laboratories. A copy is maintained in the DFRC Safety Office for reference.
- 3.1.3 National Fire Protection Association (NFPA) 45: Standard on Fire Protection for Laboratories Using Chemicals.

3.2 Guideline Documents:

- 3.2.1 NPD 1820.1: NASA Environmental Health Program.
- 3.2.2 NHB 2710.1: NASA Occupational Safety and Health Handbook.

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- 3.2.3 National Research Council (NRC): Prudent Practices for Handling Hazardous Chemicals in Laboratories. An excellent compilation of safety procedures for chemical laboratories. A summary of these procedures is listed in Appendix A, Chemical Laboratory Safety Rules.

4.0 RESPONSIBILITY

4.1 Overview

The chain of responsibility for ensuring that there is a safe work environment at DFRC that follows required safety standards, regulations, codes, and guidelines starts with the Center Director and flows downward through management to supervisors. In addition, each person who works at DFRC must understand that a “condition of employment” is to observe all safety specifications applicable to the task being performed.

4.2 Directorates and Single Letter Offices

Will approve projects, ensure resources, and provide training necessary to safely conduct chemical laboratory activities.

4.3 Safety, Health, and Environmental Office

The, Chief, Safety, Health, and Environmental Office has oversight responsibilities for chemical safety at DFRC and incurs the following responsibilities:

- Advise management on matters concerning chemical laboratory safety.
- Ensure adequate local safety policies are written for the control of hazardous chemicals in laboratories.
- Appoint a Chemical Hygiene Officer (CHO).
- Investigate chemical laboratory accidents and incidents and report findings to management and required agencies. Follow instructions in NPD 8621.1G, NASA Mishap Reporting and Investigation Policy when appropriate.
- Review this DCP annually for necessary revisions.

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4.4 Chemical Hygiene Officer (CHO)

The CHO shall be qualified by training or experience to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Program. Primary duties of the CHO are:

- Oversee the implementation of the DFRC Chemical Hygiene Program. Approve Hazard Analysis and Laboratory Safety Plan.
- Maintain a list of Particularly Hazardous Substances, as defined, that are in use at DFRC.
- Provide advice, oversight, and consultation to DFRC management, supervisors, and workers to ensure compliance with relevant regulations and policies for procurement, use, and disposal of hazardous chemicals in laboratories.
- Review laboratory procedures for the use of Particularly Hazardous Substances, as defined.
- Conduct exposure assessments of laboratories and provide findings to Directorates, Single Letter Offices, Laboratory Supervisors, and workers. Make over-exposure assessment results available to the Health Unit in order that they may be incorporated into personnel health records. Maintain a file of each laboratory's assessments in order to track discrepancies.
- Survey the operational fume hoods at least semi-annually.
- Immediately follow up on any complaints involving hazards from laboratory employees. Inform Directorates, Single Letter Offices, supervisors, and employees of findings and corrective actions taken. Notify the Health Unit when findings indicate a health hazard.
- Include any chemical laboratory safety discrepancies in the Safety Office Hazard Tracking Program.
- Review this DCP annually for currency and recommend changes to the Chief, Safety, Health, and Environmental Office.

4.5 Laboratory Supervisors

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Are directly responsible for laboratory safety and shall ensure compliance with relevant regulations, policies, and procedures. Laboratory Supervisor's responsibilities are:

- Review, understand, and approve each laboratory procedure to include the hazards of the chemical/s involved, safety measures to be used, and personal protective equipment needed.
- Develop a general laboratory safety plan for standard operations. In addition to the standard plan a Hazard Analysis will be developed for each project that uses Particularly Hazardous Substances, as defined. See Section 6.0, Hazard Analysis and Safety Plan.
- Ensure that employees working within the laboratory have the training and knowledge to complete projects safely.
- Maintain an up-to-date chemical and toxic material inventory.
- Ensure that resources necessary to safely complete a project are available.
- Ensure that Material Safety Data Sheets, operating procedures, and other appropriate documents are made available to laboratory employees.
- Conduct informal safety and housekeeping inspection daily when the laboratory is in operation.
- Post danger and warning signs, such as National Fire Protection Association (NFPA) chemical warning signs, where required.

4.6 Laboratory Workers

- Will have proper training and knowledge to perform assigned tasks and will follow safe, established laboratory work procedures.
- Will understand and follow safety procedures required by each project. If a worker has questions regarding safety procedures he/she shall request clarification from the Laboratory Supervisor before continuing.
- Immediately report any concerns of unsafe or unhealthy working practices or conditions.

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- Immediately report any ill effects experienced to the Laboratory Supervisor and seek medical consultation at the DFRC Health Unit.

4.7 Off-Site Contractors and Visiting Experimenters

- Will follow this or a Chemical Hygiene Plan approved by the CHO and also adhere to relevant safety regulations that pertain to the project being conducted.
- Will provide the CHO with a summary of the project/s to be accomplished including the hazardous chemical/s to be used, precautions to be taken, and PPE required.

4.8 Contracting Officer Technical Representative (COTR)

- Evaluates compliance with this or the contractor's Chemical Hygiene Plan and relevant safety regulations governing the contractor's chemical laboratory operations.
- Notifies the Dryden CHO or Safety Office of any non-compliance safety issues.

5.0 CONTROL MEASURES

The large number and variety of hazardous materials and their many uses does not allow a review of each possible situation that may be encountered in a laboratory setting. To help solve this problem general control measures have been developed to provide a framework for minimizing chemical laboratory risks.

5.1 Types of Controls

- 5.1.1 Chemical Substitution: In many cases, a highly toxic chemical may be substituted for one that is less toxic. An evaluation to determine the least toxic materials that satisfy requirements of a project will be made by the Laboratory Supervisor.
- 5.1.2 Engineering Controls: Good engineering controls are essential to safe laboratory operations. Consideration for containment, ventilation,

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enclosures, adequate work space, and general facility design will make a laboratory a much safer place to work.

- 5.1.3 Administrative Controls: Administrative controls include written safety procedures, training requirements, access control, medical surveillance requirements, record keeping, and documentation.
- 5.1.4 Personal Protective Equipment (PPE): Training in the use of PPE is mandatory for persons working in a chemical laboratory. Chemical Laboratory PPE may include, respirators, face shields, gloves, and protective clothing.
- 5.1.5 Work Practices: Work practices are possibly the most important safety aspect of a chemical laboratory. Work practices include both personal hygiene habits and laboratory techniques. See Appendix A, Chemical Laboratory Safety Guidelines, for a summary of laboratory safety practices.

6.0 HAZARD ANALYSIS and SAFETY PLAN

6.1 Hazard Analysis

Prior to conducting a project the Laboratory Supervisor will ensure that a Hazard Analysis is conducted whenever Particularly Hazardous Substances, as defined, are used. The Hazard Analysis will be reviewed and approved by the CHO. The Hazard Analysis will include:

- 6.1.1 Inherent toxic and physical properties of the materials and their intended use.
- 6.1.2 Possibility of unplanned outcomes, spills, or accidents.
- 6.1.3 Workplace factors, such as existing ventilation, protective systems, and the need for PPE.
- 6.1.4 Possible exposure routes (inhalation, skin or eye contact, or ingestion).
- 6.1.5 Skills, training, and prior experience of the individual performing the project.

6.2 Laboratory Safety Plan

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Prior to conducting a project the Laboratory Supervisor will ensure that a Laboratory Safety Plan is developed that conforms to CFR 1910.1450. This Safety Plan will be reviewed and approved by the CHO. See Appendix B, Laboratory Safety Plan Outline for guidance in developing this plan.

7.0 MEDICAL

The Health Unit provides emergency medical care for all persons who become exposed to hazardous chemicals at DFRC.

7.1 Health Unit

Employees will be referred to the Health Unit:

- For baseline examination when working with substances that require medical surveillance.
- If they experience headaches, dizziness, nausea, rashes, mental confusion, or loss of motor control that could be related to the handling of a chemical.
- When air monitoring indicates toxic chemical air levels that exceed the PEL or TLV[®].
- When an event such as a spill, leak, or explosion results in an exposure.

The emergency 911 telephone system will be used to notify the Health Unit and Safety Office of a reportable acute exposure.

7.2 Employee Exposure

If an employee is exposed to a hazardous chemical and requires medical attention, medical personnel will be informed of:

- Any signs or symptoms described by the employee and symptoms other employees may have seen in the employee or experienced themselves.
- The name and nature of the chemical, how the chemical was being used, and its MSDS.
- The results of any monitoring or testing that was done to determine the level of exposure.
- Follow-up care, within the capacity of the Health Unit, will be provided to DFRC civil servants. Non-civil service personnel will be referred to their company's physician or private practitioner for further treatment and follow-up evaluation.

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If the Health Unit is unable to provide the required level of care needed the patient will be referred to a facility which has the capability.

7.2.1 Pregnant Workers

The Laboratory Supervisor shall inform each female worker under his/her supervision who is of childbearing age to immediately declare her pregnancy in writing should it occur. Once declared, the pregnant worker will be monitored for exposure to certain materials that could affect the fetus. Chemicals that must be carefully handled or avoided by the pregnant worker are those listed as embryotoxins, mutagens, or teratogens.

8.0 INFORMATION AND TRAINING

Occupational Safety and Health Administration (OSHA) requires that chemical laboratory employees be provided with specific information about the chemical hazards in their work area and be trained on how to safely work with such chemicals.

8.1 Required Information

Each employee will be given the following information:

- Location of hazardous chemicals in the work area at the time of initial assignment and before each new assignment that involves chemicals to which the employees may be exposed.
- PELs or TLVs[®] for OSHA regulated substances used in the employee's job assignment. For a list of the most current PELs and TLVs[®] contact the Safety Office.
- Information on the effects, signs, and symptoms of exposure to hazardous substance being used.
- Location and availability of standard reference materials on the hazards found in the individual laboratories, including safe handling, storage, and disposal procedures for those hazardous chemicals.
- Location of Chemical Hygiene Plan, laboratory procedures, MSDSs, OSHA standards, emergency telephone numbers, and other documentation of importance to the safe accomplishment of a specific project.

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8.2 Training

Laboratory employee training is similar to Hazard Communication training required by 29 CFR 1910.1200 and shall consist of:

- Methods and observations used to determine the presence or release of a hazardous chemical such as monitoring devices, visual appearance, and odor of chemicals being used.
- Methods that employees can take to protect themselves from hazards. These include appropriate engineering and administrative controls, PPE, work practices, and emergency procedures.
- Review of the physical and health hazards that can occur in the work place, including flammable and reactive materials, irritants and corrosives, acute poisons, chronic organic toxins, allergens, and genetic toxins.
- How to extract needed information from a Material Safety Data Sheet (MSDS).
- The proper labeling, storage, and waste disposal procedures for all levels of chemicals.
- Review of the requirements in the local Chemical Hygiene Plan.

8.3 Refresher Training

Refresher training for chemical laboratory operations is not defined in OSHA standards, however, Laboratory Supervisors are encouraged to evaluate the need for refresher training for employees and provide training when procedures, chemicals, or equipment change.

8.4 Documentation

The Health Unit will provide a written report to the patient's supervisor or contract site manager identifying:

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- The results of medical examination and associated tests and what medical follow-up are needed, (within limits of the Privacy Act of 1974).
- Medical condition/s found that could place the employee at increased risk as a result of chemical exposure in the workplace.
- A statement that the employee has been informed by a physician of the results of the examination and what follow-up care is advised.

9.0 RECORDS

9.1 Laboratory Supervisor

The Laboratory Supervisor will keep an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by 29 CFR 1450. The Laboratory Supervisor will assure such reports are kept, transferred, and made available in accordance with federal and state requirements.

The Laboratory Supervisor will keep records such as receipts, inventories, transfers, hazardous materials disposal records, etc., in a separate working file for each project. A record of all hazardous materials used as listed in 29 CFR 1910.1000 Subpart Z, must be included. After completion of the project a disposition for the records will be made using NPD 1441.1: Records Retention Schedules as a guideline.

9.2 Chemical Hygiene Office

The CHO is responsible for maintaining a copy of records and receipts such as approval requests and authorizations, procurement, inventories, surveys, calibrations, bioassay results, exposures, waste disposal, and any other records that pertain to the use of hazardous materials as listed in 29 CFR 1910.1000, Subpart Z. Following the completion of the project a disposition of these records will be made similar to those of the Laboratory Supervisor's.

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APPENDIX A

CHEMICAL LABORATORY SAFETY GUIDELINES

1.0 General Safety Procedures

The following safety procedures have, for the most part, been taken from 29 CFR 1910.1450, Appendix A. These safety practices represent “good judgment” that must be used when hazardous chemicals are used. An excellent source of laboratory safety procedures is the National Academy of Science publication: Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, 2101 Constitution Ave., NW., Washington, D.C. Laboratory supervisors may obtain a copy of this publication from the DFRC Safety Office.

- 1.1 Do not smell, taste, or use mouth suction for pipeting or starting a siphon.
- 1.2 Vent apparatus (e.g., vacuum pumps and distillation columns) that may discharge toxic chemicals into local exhaust systems. Do not release toxic substances into “cold” or “warm” rooms as these rooms may have contained recirculated atmospheres.
- 1.3 Handle and store laboratory glassware carefully to avoid damage; do not use damaged glassware. Use extra care with Dewar flasks and other evacuated glass apparatus; if necessary, shield or wrap them to contain chemicals and protect garments in case an implosion occurs. Use equipment only for its designed purpose.
- 1.4 Carry hazardous chemicals in a secondary container. In many cases a bucket type container serves this purpose.
- 1.5 Wash exposed areas of skin well before leaving laboratory.
- 1.6 Avoid practical jokes or other behavior that might confuse, startle, or distract another worker.
- 1.7 Confine long hair and loose clothing. Wear shoes. Sandals and perforated shoes are not permitted in the laboratory.

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- 1.8 Keep work areas clean and uncluttered: clean up after completing an operation and at the end of each shift. Ensure that chemicals and equipment are properly labeled and stored.
- 1.9 When possible, do not wear contact lenses in the laboratory. If contact lenses must be worn, inform supervisor so that special precautions may be taken.
- 1.10 Remove laboratory coats and other clothing immediately if contaminated. Bag all contaminated clothing.
- 1.11 Keep materials stored in hoods to a minimum: do not allow materials to block vents or the airflow. Use only the quality and quantity of chemicals which the ventilation system can handle.
- 1.12 Leave the fume hood "on" when not in use, especially if it contains toxic substances or if it is uncertain whether adequate general laboratory ventilation will be maintained when the hood is "off."
- 1.13 If chemical gets into the eyes, flush for 15 minutes and obtain medical help. For skin contact, flush with water and if symptoms persist seek medical assistance.
- 1.14 If a chemical is ingested immediately contact the Health Unit using the emergency 911 telephone system. Encourage the victim to drink large amounts of water ONLY if approved for the specific chemical, has been approved by a medical doctor, the Poison Control Center, or MSDS.
- 1.15 MSDSs shall be available to employees at all times.
- 1.16 Eating, drinking, smoking, chewing gum, and applying cosmetics must be avoided.
- 1.17 Do not conduct a hazardous procedure when you are the only person in the laboratory.
- 1.18 Know and follow proper waste disposal procedures.
- 1.19 Use approved procedures for using allergens and embryotoxins. Women of child bearing age must take special care, such as using PPE, especially gloves, to avoid contact when working with embryotoxins.

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- 1.20 Review the use of allergens and embryotoxins with laboratory supervisor. Notify supervisor of any releases, spills, exposures, etc., and contact the Health Unit.

2.0 Working with Chemicals of Moderate Chronic or High Acute Toxicity

- 2.1 Minimize exposure to these toxic substances by any route using all reasonable precautions.
- 2.2 Store in a restricted area with required warning signs.
- 2.3 Use with an approved hood or other containment devices for procedures that could generate aerosols or vapors. If possible, trap released vapors to prevent discharge.
- 2.4 Avoid contact by using proper PPE and always wash hands and arms immediately after working with these materials.
- 2.5 Take precautions to prevent spills. Use secondary containers if primary container is breakable. Always ensure two people are in the laboratory when these chemicals are in use.
- 2.6 Handle waste materials appropriately.

3.0 Work with Chemicals of High Chronic Toxicity

- 3.1 Conduct all transfers and work with these substances in a controlled area such as a hood, glove box, or a designated area within the laboratory. Ensure each substance is clearly labeled, and that the designated area is properly marked. Ensure all persons working in the laboratory are aware of the substances being used, the restrictions, and the precautions required.
- 3.2 Protect equipment from being contaminated and always decontaminate the controlled area before it is used for other projects.
- 3.3 Remove protective apparel, wash hands, arms, face and neck. Place apparel in appropriately labeled containers to be disposed of as hazardous waste or decontaminated and cleaned for further use depending on the exposure and substance used.

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- 3.4 Do not sweep powdered toxic materials, use wet mop or a vacuum cleaner with HEPA filter.
- 3.5 Have an emergency plan to protect persons, equipment, and materials in case of an accident.
- 3.6 Store properly labeled substances in a clearly marked, limited access, substantial and ventilated cabinet. Substances will be contained in non-breakable or secondary containers. When storing toxic substances, take into consideration that DFRC is located in a seismic active area.
- 3.7 Keep records on substances used and inventories on hand.
- 4.0 Animal Experiments with Chemicals of High Chronic Toxicity
 - 4.1 Administer substance by injection or gavage instead of diet when possible. If substance is given by diet, a caging system with negative pressure under laminar airflow directed toward HEPA filters will be required.
 - 4.2 Minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces. Use HEPA filtered vacuum equipment for cleaning. Dampen contaminated bedding before removal from cage and mix diets in closed containers in a hood.
 - 4.3 Wear plastic or rubber gloves and fully buttoned laboratory coats or jumpsuits when working in the animal room.
 - 4.4 Specially designed facilities with restricted access are preferred for long time or large scale animal studies.

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APPENDIX B

LABORATORY SAFETY PLAN OUTLINE

1.0 General

Laboratory Supervisors are responsible for ensuring that a safety plan is developed before toxic chemicals or substances are used in the laboratory.

The following outline is included, as a guideline, to assist in developing a laboratory safety plan.

2.0 Laboratory Safety Plan Outline

2.1 Name of responsible:

- Code _____
- Directorate or Single Letter Office _____
- Project Supervisor _____
- Laboratory Supervisor _____
- Laboratory Employees _____, _____
_____, _____, _____

2.2 Location of Laboratory _____

2.3 Permits needed such as for controlled drugs, radioisotopes, laser, confined space, etc. _____, _____ _____, _____, _____

2.4 Hazard Analysis completed (date) ____/____/____ (See Section 6, Hazard Analyses and Safety Plan, for requirements)

2.5 Name of substances to be used _____, _____ _____, _____, _____

2.6 General description of procedures and processes to be used, (Add an attachment if process so indicates.)

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- 2.7 Written procedures for particular hazardous substances, (Add an attachment if needed.)

- 2.8 Equipment needed (ventilation, ovens, refrigerators, flame generators, etc.)

- 2.9 Access control, (warning signs, access badges, door locks, etc.)

- 2.10 Laboratory personnel training requirements

- 2.11 Emergency procedures for spills, releases, fire, emergency shutdown, etc. (Add an attachment if needed).

- 2.12 Inspection schedules

In-house _____

Safety Office _____

External agencies _____

- 2.13 Chemical inventory schedule _____

- 2.14 Document location:

Training records _____

Inspection records _____

ALL DOCUMENTS ON THIS SITE
<http://www.dfrc.nasa.gov/DMS/dms.html>
 ARE FOR REFERENCE ONLY
 THIS SITE IS UPDATED EVERY 30 DAYS

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Chemical inventories _____

Others (list) _____

2.15 Personal Protection Equipment needed

2.16 Waste disposal procedures (May require a separate document if process so indicates).

Waste permits required _____

Waste procedures to be used _____

